

IMPROVING THE FORKLIFT TRAFFIC SAFETY AT LOGISTICS TERMINALS

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<p>Abstract</p> <p>The objective of this thesis was to map out the current working safety situation related to the forklift traffic at DB Schenker Cargo Ltd. The thesis was made for DB Schenker-terminals in Metsälä, Helsinki. The mapping out consisted of evaluating the current situation and finding possible problem areas. In addition, the objective was to create improvement suggestions to the current situation and develop functional solutions for the warehouses built in the future.</p> <p>The structure and approach methods were created in co-operation with DB Schenker Cargo Ltd. This thesis relies mainly on empirical study methods, and in practice the mapping was carried out by interviews, questionnaire forms and personal visits to the warehouses.</p> <p>Information gathered revealed that there are many issues to be improved such as lack of space, attitude problems, old-fashioned premises and lack of safety clothing. The improvements include re-organizing the premises, new ways of motivating and added effort on safety issues.</p>		
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Tiivistelmä Tämän työ tarkoitus oli kartoittaa DB Schenker Cargo Oy:n terminaalitilojen turvallisuus liittyen niissä tapahtuvaan trukkiliikenteeseen, ja löytää mahdollisia ongelma-alueita trukkiliikenteessä. Lisäksi tavoitteena oli kehittää mahdollisia parannusehdotuksia trukkiliikenteen turvallisuuden parantamiseksi nykyisiin tiloihin, sekä kehittää toimivia ratkaisuja tuleviin varastorakennuksiin. Työn rakenne ja toteutustapa kehitettiin yhteistyössä DB Schenker Cargo Oy:n kanssa. Työ perustuu pääosin empiirisiin tutkintatapoihin, ja ongelma-alueiden kartoituksessa lähestymistapana käytettiin haastatteluita, haastattelulomakkeita sekä henkilökohtaisia vierailuja varastotiloissa. Koottu informaatio paljasti parannettavia epäkohtia muun muassa käytettävissä olevissa tiloissa, asennekysymyksissä sekä puutteellisessa turvavaatteiden käytössä. Parannusehdotukset sisältävät muun muassa tilojen uudelleen järjestämistä, henkilökunnan uusia motivointitapoja sekä huomion keskittämiseen työturvallisuusasioihin.		
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1. THE PURPOSE OF THIS THESIS

Forklift traffic means the moving of vehicles and people inside a warehouse, and their relation to each other. In this thesis forklift traffic consists of pedestrians, electric, diesel and liquid petroleum gas forklifts and electric pallet trucks (see Figure 1). The term traffic was limited in such a way on the basis of the requirements and wishes of the personnel at DB Schenker Cargo Oy.

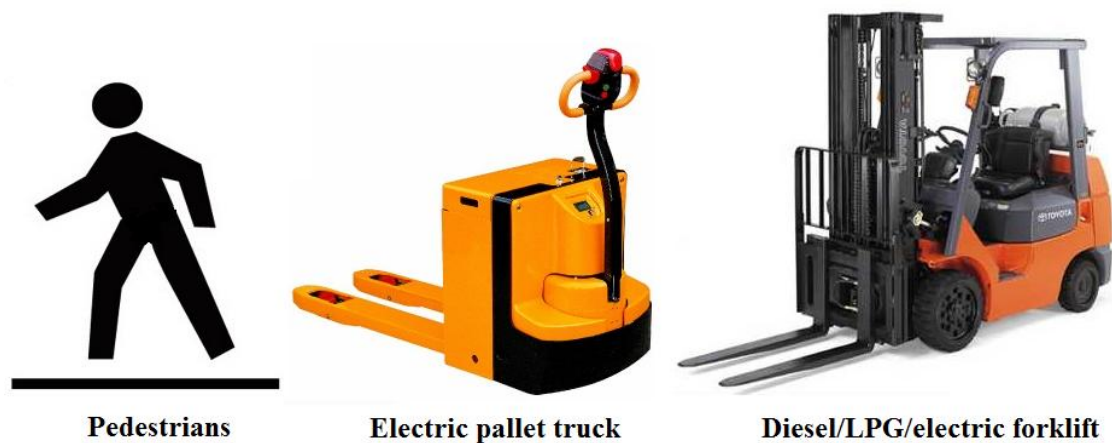


FIGURE 1. The parties forming the forklift traffic at DB Schenker Cargo Oy

The forklift traffic in warehouses causes severe costs for DB Schenker Cargo Oy on a yearly level. These costs are caused by issues such as material damages and sick absences. The material damages are costs which come from goods being damaged. These damages can occur when goods are run over, dropped from heights, unloaded or loaded in a wrong way or similar material handling mistakes. An absence from work is likely to happen when a forklift hits somebody, falls over, hits a solid object or there happens other mistakes in handling the forklift. In order to minimize material damage costs, improve working safety and minimize the lost working days due to accidents, all the risks have to be mapped out and all the conflicts solved. The secondary aim of this thesis was to identify all possible risks concerning forklift traffic, and forklift traffic's relation to material damages and working safety risks at the DB Schenker terminals in Metsälä,

Helsinki. The main aim was to solve these problems, discover ways to improve the current situation and, in addition, look to the future and the future warehouses. It is expected that DB Schenker Oy will move into a new location within the following years. Therefore it is important to analyze the current situation and avoid making the same mistakes concerning the forklift traffic in the new location.

2. DB SCHENKER

2.1 DB Schenker

DB Schenker is the Transportation and logistics-division of the Deutsche Bahn AG and one of the leading service providers in the world of logistics. The company offers not only transportation by air, sea, rail and road, but in addition it provides solutions for complicated supply chains. The revenue of the company is around 18 billion Euros and the company has over 91 000 employees in around 2000 different locations around the world. According to the business report in 2006, DB Schenker was the market leader in Europe in railway and road transportation.

2.2 DB Schenker in Finland

DB Schenker has four different divisions in Finland. Schenker Oy provides international transportation in all modes of transportation. JOT Kotijakelu offers home delivery services. Oy Schenker East Ab is responsible for the operations in Eastern Europe. The division for which this thesis was done is Schenker Cargo Oy. Schenker Cargo Oy provides mainly warehousing, transportation and other logistics services inside Finland. The division includes Schenker Express offering fast deliveries on small parcel services. Schenker Cargo Oy is also responsible for Kiitolinja's operations.

2.3 Metsälä Terminal

Figure 2 shows the purposes of the different terminals and their relation with each other at Metsälä. The terminals are physically located this way at the Metsälä terminal and they are in the same proportion, as all of them are roughly the same size.

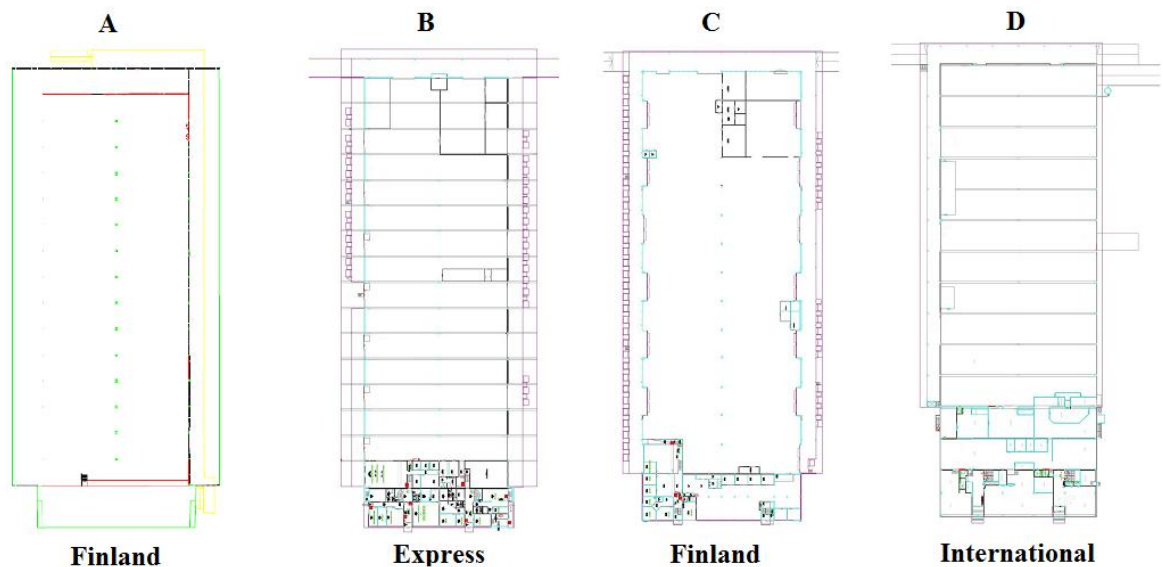


FIGURE 2. The terminals at Metsälä

Terminal A and C are used for warehousing and transporting goods inside Finland.

Terminal A focuses mainly on larger household electronics, such as washing machines and fridges, and terminal C is used for a wider variety of different goods. Terminal A focuses mostly on distribution inside Finland where as C terminal handles in addition long-distance haulages with only one or a few destinations. Terminal B is used by Schenker Express, and the operations are widely automated. In terminal B there is only one forklift and, due to the lack of sufficient forklift traffic, terminal B is excluded from

this thesis. Terminal D is reserved for international transportation, such as export and import.

3. RESEARCH METHODS

In co-operation with Schenker Cargo Oy it was agreed that the best way to approach this thesis is by doing an empirical, qualitative study. Every warehouse differs from another and the work would not have been sufficiently accurate by doing only a quantitative study on the subject. A qualitative study allowed this thesis to be tailored to Schenker Cargo Oy, and especially the Metsälä terminal. This thesis used some quantitative study methods but primarily it relied on interviews, questionnaire forms and general observations made while visiting the warehouses. By using these three qualitative methods it was possible to receive information from different levels, ranging from the worker up to the head of the terminal, and to obtain a clear and complete overall picture of the current situation. The information received from different levels provided different opinions as most expectedly employees and foremen had differing opinions about the subject. These combined with the author's own personal notes by visiting the terminals provided a great deal of information and helped to take every party into account, on which it could be focused on and third party opinion could be obtained.

3.1 Questionnaire Forms

Due to the great number of warehouse workers and truck drivers, it was decided that the easiest and less time consuming way to contact this group was to create a questionnaire forms that would be given to them to fill out (see Appendix 1). Based on the number of workers around 100 forms were developed and printed out. 20 of the forms were left to be filled out at the A terminal, 40 at the C terminal and 40 at the D terminal. The distribution of the forms was again based on the number of workers and the amount of traffic in every terminal. The forms were left at the workers' break room and the foremen were told to

encourage the employees to fill them out during their breaks. As an encouragement on the author's behalf it was promised to raffle five lunches at their restaurant. Terminal B was left out this project, as mentioned previously, due to its high level of automation and small amount of forklift traffic.

The questionnaire forms were four-folded. In the first part, some general issues were asked such as sex, age and working history. The idea behind these questions was to see whether age group, sex or experience reflected on the answers to the questions. The second part consisted of possible work accident history. The purpose was to see whether there was a certain pattern in the answers. The possible pattern could reveal some aspects in the occupational safety. The third part was about the current working safety situation. The purpose of the questions about the current situation and problems was to reveal some aspects in the working safety. The fourth part was about how they would improve the situation. The question was left open and basically the employees could answer anything they wanted. Even though their answers could be very hard to fulfill in real life, the point of this question was to obtain some ideas and perhaps modify them into a more useable form.

3.2 Interviews

It was attempted to make the interviews very open and as the basis for the interviews the same questionnaire was used with only one additional question (see Appendix 2). The questionnaire was, however, supposed to work more as a general guideline rather than a strict content of the interview. In practice, the interviews were designed to be very open, and space was left for the questions to be made up during the interview. It was expected that most probably some of these questions would need extra questions to clarify them and specify the answers. In addition, it was expected that there would be some questions that the forms did not even include. In order to keep track of the interviews, besides making notes, the interviews were recorded for possible further examination.

Again, in co-operation with the human resource personnel, it was decided that in total five people would be interviewed. These people included one foreman or representative per terminal and the person responsible for the working safety at DB Schenker Cargo Oy. The interviews were to be carried out during three days in week 27. The time reserved per person was approximately one and a half hours. Even though terminal B was excluded from this thesis, it was decided to interview its representative as this representative could be able to give information about the other terminals from the point of view of a person not working there.

3.3 Visits

As the third method, the author decided to make own personal notes about the terminals. A list was made about what to take into account and what to observe in these terminals (see Appendix 3). The list was made partly by author's own personal working experience but in addition by exploring Work safety guides and –instructions 21 by the Work Safety Administration. The list consisted of legislation issues, preferences and general observations, such as cleanliness and driving speeds. This list was more of a guideline with a great deal of empty space to write onto. The topics listed were the minimum to observe and notes were to be made of other issues that would arise. The list was made before the interviews and from the interviews additional important information was received on what to focus on especially.

The visits were made in week 27, in the same week as the interviews. From the interviews at the beginning of the week information was received concerning, not only the problems on which to focus, but in addition the operational hours of the terminals and when the traffic would usually hit its peak. However, it would be better to visit the terminals many times from which one would be at a calmer time to obtain an exact picture of the current

situation. Therefore the terminals were to be visited at least twice depending on the times. Terminals should be visited at least during the rush hour and at a quieter time. Eventually Terminals A and B were visited twice and C three times due to its relatively different operations.

4. INTERVIEW RESULTS

The interviews were conducted during Monday, Tuesday and Thursday in week 27. There were scheduled two interviews on Monday 5th July 2010, two interviews on Tuesday 6th July 2010 and one interview on Thursday 8th July 2010. The people interviewed were, respectively, the working safety responsible, a foreman at the terminal C, the manager of terminal B, a foreman at the terminal D and the summer foreman at terminal A. For every interview approximately one and a half hours of time was reserved. The actual time needed fluctuated between half an hour and one hour and fifteen minutes depending mainly on the willingness and activity of the interviewed person.

All of the interviewed people had several years of experience in the field of logistics. The summer foreman at A terminal excluded, they had worked at DB Schenker for several years. The experience gathered from other companies, and especially the multiple years at DB Schenker, affected their answers greatly. Even though experience usually leads to expertise and a high level of knowledge of warehouse operations and safety, the main disadvantage is that they are used to working in these warehouses. It has to be taken into account that this leads them into not being able to see the subject in a completely objective way. Reasons for finding the current safety situation sufficient included the use of blinkers and the right driving methods, such as reversing if the load was too high and blocking the driver's view. The main reason for finding the situation sufficient appeared to be, however, that most of the warehouse workers had worked there for a very long time and they knew how to work with each other. The employees knew each other's methods

and what to watch out and how to cope with different situations. It was acknowledged that it caused problems when external people entered the warehouse, such as visitors, or when new employees started working in the warehouse.

From the five persons, only the working safety responsible found the situation poor. The other four found that the situation was good or average, but they clearly had problems evaluating the situation. It is quite remarkable that the working safety responsible found the situation to be extremely poor and he felt that the situation had reached such a state that a severe injury, or even death, of a worker was becoming more probable every day.

Of the five people, three had been involved at least in one working accident. There was a pattern that could be seen as several accidents could be linked to pallet handling. In one case the pallet was broken and there was one runner missing. Therefore the pallet was unstable and fell on the worker. In addition, there was one case where a high cage pallet fell on a worker when the pallet was driven through a corner. The high, unstable pallet full of car spare parts started to tip over during the turn and finally fell over mildly injuring the person who was standing on the outer side of the corner. Sometimes there are pallets arriving which are loaded with glass. Some of these pallets are not packed properly at the arrival point and they are lacking in important supports. In these cases, one person has to stand, support and move with the pallet as it is moved inside the warehouse in order to keep the goods safe and avoid material damages. This has caused at least twists to thumbs. Besides causing danger, these pallets require extra work force as they cannot be moved by one person. Problems with these glass pallets are said to be quite usual and often cause dangerous situations.

When asked about the different problem areas, there was mutual agreement on certain aspects. Three of the people interviewed agreed that speed and insufficient space were real problem areas. One important issue mentioned was the amount of crossing traffic.

This is connected to the amount of space as the terminals are relatively old, and have not been built for today's standards. They are insufficient considering the amount of goods transported and warehoused nowadays and the forklift traffic needed to move these amounts of goods in and out of the warehouse. The age can be noticed in the overall condition as there are bumps on the floor and other problems with the surfaces and loading platforms. One problem related to the traffic is that it varies a lot during the day. Every single terminal has its busy hours and the amount of goods in the warehouse varies a lot. This makes it hard to evaluate the actual need for the space. The space in the warehouse has to meet certain requirements; it has to be sufficient in size to fill the actual need considering the amount of goods, it has to provide sufficient space for the safe working, but in addition it has to try to keep the variable costs down and avoid unnecessary heating, electricity and other running costs. The main dilemma in designing warehouses is to balance between the running costs and the space. The warehouse has to be cost-efficient but still enable safe working and provide sufficient space.

Besides speed, space and crossing traffic, several other safety and material damage related issues were mentioned. Other issues were, however, more of individual observations which varied between different people. Attitude problems, or issues closely related to it, were mentioned twice. There is some forward driving done at places where it should not be done causing danger to the goods and personnel, and fast driving at places where it should not be done, for example at automatic doors where one has to wait the door to open. Besides attitude problems, which are the root cause for not caring about the goods or other people, there is a lack of foremen, there are simply not enough foremen to guide and oversee the warehouse workers. Furthermore, it was mentioned that even though there were a sufficient amount of foremen and tighter control, the initial attitude problems would reflect on the warehouse workers' behavior and in any case they would not listen to what the foremen have to say or listen to their advice. To be quoting one of the answers: "There is no respect towards the goods or other workers." (Seppo Ihatsu, 5th July 2010).

One of the problems frequently mentioned was the problem of trespassers or other personnel walking on the ground level. They should not be there, but the truth is that it cannot be avoided. Countless truck drivers and warehouse workers, while gathering their loads, have to walk around the pallets looking for the shipping information written on to the goods. It was mentioned that there are very often pallets with very high loads, for example fridges, in the terminals. The loads are so high that even forklift drivers, who sit quite high in their machines, are not able to see whether there are people coming from behind the goods while driving on the drive ways. This leads to another problem related to the pedestrians: pedestrians are not taken into account in any way in the current situation. The lack of sidewalks forces the pedestrians to walk on the same routes used by the forklift drivers and between the warehoused goods. This connected with the fact that, as some of the interviewed people mentioned, it is not obligatory to wear a safety vest while being inside the warehouses may cause very severe injuries at some point.

There was no clear common agreement on the additional question concerning the most likely age group to cause problems. Most of the interviewed people agreed that the problems in the warehouses can be caused by basically anyone, and it is not dependant on the age of the person. However, older workers have a lot more experience and they are therefore better workers what comes to material damages and overall working safety. It was said that, for example, there is no difference in the driving speeds between the young and the old, but despite the speed driven, the additional experience over the years makes the older workers less of a subject to material damages or human injuries. Hence the question is more of the experience, not of the age itself. The lack of experience usually reflects more on the common handling of the machinery. This is said to be especially problematic when there are several new workers in the warehouses. One or two new workers can be easily handled and instructed but if the number of beginners increases from this, the safety decreases. In addition, even though the workers had previous warehouse working experience, new workers might have problems due to the lack of experience in this specific warehouse. Older workers, who have worked in these warehouses for a long time, tend to have their own working methods and this causes problems for the new workers. New workers usually tend to be young people, and

therefore it may be that they may not even have the general knowledge of how to work in a warehouse.

5. QUESTIONNAIRE RESULTS

The percentage of people answering the questionnaire ended up being extremely low. Only eleven people out of 100 filled out the questionnaire form resulting in the answering activity of 11%. None of the personnel at the C terminal filled out the form, despite being frequently asked them to fill it out. From the other two terminals there were eight answers coming from the D terminal and three from the A terminal.

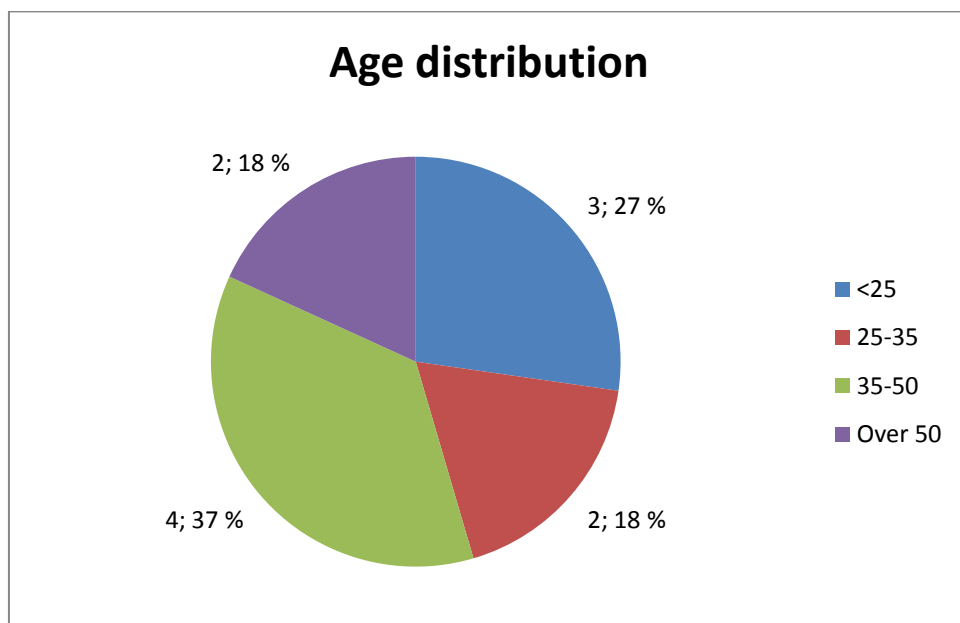


FIGURE 3. The age distribution among the answers

Even though the answering activity was really low comparing to the maximum amount, the age distribution became relatively even (see Figure 3). This ensured that it was possible to obtain opinions and insights from people of different ages and experiences. The working experience in the field of logistics varied between six months and thirty-three years and at DB Schenker between three months and thirty-three years. The average

experience in the field of logistics varied from 1,8 years to 27,5 years and at DB Schenker between 1,3 and 27,5 years. The results were as expected; experience grew in relation with the age group as can be seen in Table 1. What should be noted was that none of the people answering the questionnaire had formal education in the field of logistics. Only one answer indicated that studies at a university of applied sciences were to be completed at some point.

TABLE 1. The logistics experience of the participants

Age group	Average experience in logistics (years)	Average experience at DB Schenker (years)
<25	1,8	1,3
25-35	10	9,3
35-50	18,4	13,9
Over 50	27,5	27,5

When asked whether the participants had been involved in working accidents, only a few had suffered from bad working injuries (see Figure 4). Most of the answerers had not been involved in any sort of accident, or at least did not recall being involved in working accidents. There had been some minor injuries such as back sprains, finger or hand injuries, knee injuries or small material damages. The minor injuries in this thesis are injuries that do not threaten life or cause irreversible damage to the goods or people. One major accident had occurred when a trailer had not been secured with a load binder during spring time. The trailer moved forwards when the forklift was driving into it and the forklift fell from the loading platform on to the ground. The driver was, however, not injured as he was able to jump from the forklift before it fell on to the ground.

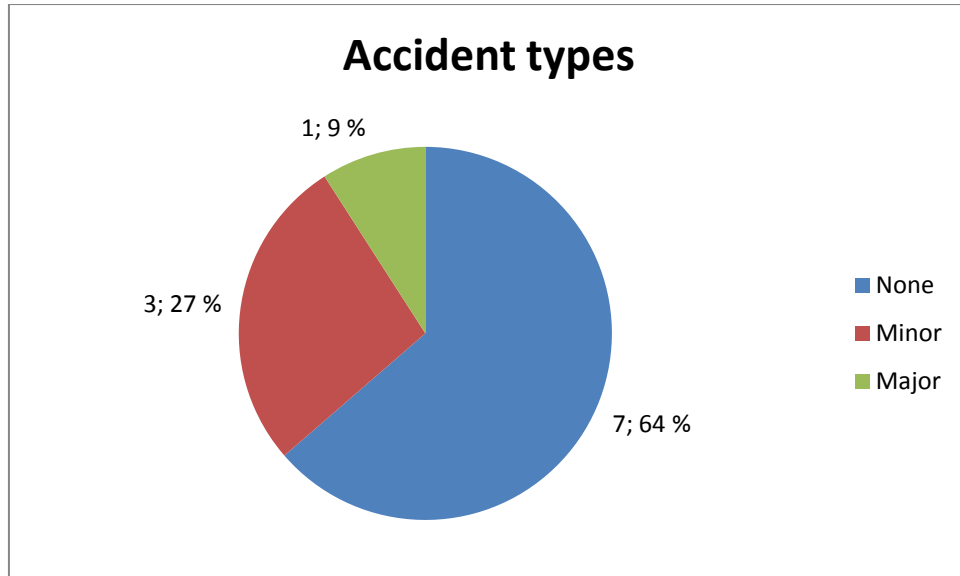


FIGURE 4. Accidents happened and their types according to the answers

As almost no one had been involved in a working accident, the current situation was found to be sufficient. Almost everyone answered that the current situation is sufficient or fine. One person answered that the situation was poor. What is to be noted is that even though everyone was satisfied with the situation now, no one claimed the situation to be excellent or very good.

One of the reasons for the situation being sufficient was that they found that it was very safe to work in the warehouse if one kept track of the surrounding situation and traffic. Several people answered that with the use of common sense and by using one's eyesight and hearing, one was able to work very safely and working accidents were very unlikely to happen. Other reasons included small traffic amounts (at least in the A terminal) and that problematic issues are dealt very rapidly when they occurred and therefore safety-related issues were improved when necessary.

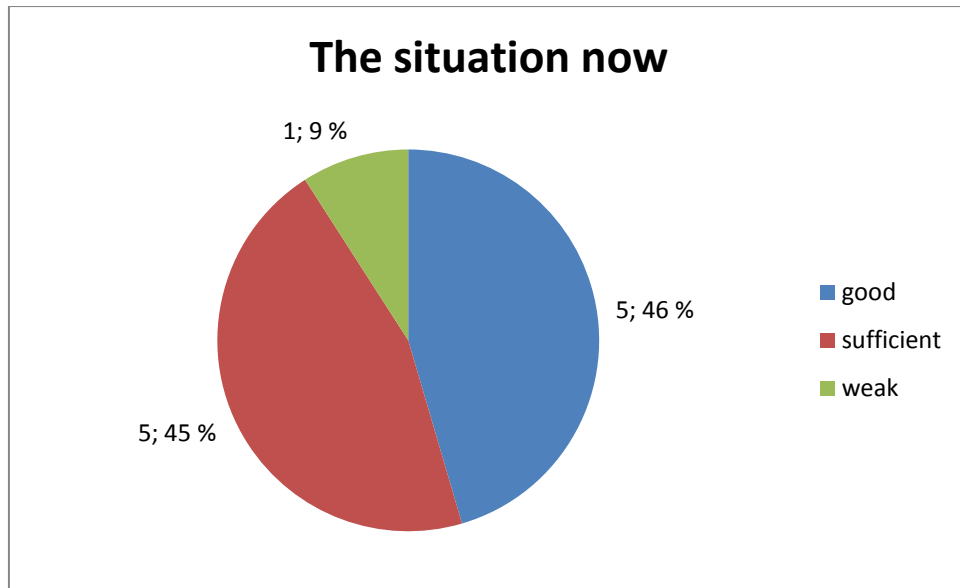


FIGURE 5. The safety of the current situation

As for the problems, a few issues were frequently mentioned. The two main concerns were driving speeds and insufficient space. Several answers said that the driving speeds were too high, and that driving at times reminded more racing than working. Especially these two problems arise during the rush hours when everyone tries, and has, to work at full speed and there are vast amounts of goods in the warehouses. In addition, unwanted rush and hurry were mentioned as very problematic. The amount of goods usually reflects on the variety of goods. Therefore there are numerous different shaped and sized goods moved which block the view of the driver because they are too high or wide. In addition, it was mentioned that there were wrong kinds of goods stored inside the warehouses. These goods include goods that are too heavy or large to be handled inside the warehouses and they should be stored outside. The exceptional shape and size of these kinds of goods cause danger to the equipment, personnel and other goods as they are moved, but in addition they cause blocks and obstacles for moving in the warehouses by minimizing the already small warehouse spaces.

Other smaller, less frequent problems included worries about the working ergonomics. One person was worried about the damage that driving a forklift may cause to one's back. The same person had concerns about the reliability of the working equipment and

machinery, especially the seats in the forklifts and the reliability of its joints. Terminal A was found to be in a considerably bad shape. The poor condition of the warehouse and its floor surface was believed to cause severe safety risks. More related to the D terminal, lifting some pallets up to the shelves was mentioned. This was most probably due to unstable pallets or pallets that were extraordinary in size or shape but needed to be put into the shelves. One reason for this was the windows on the ceiling. Sometimes the sun shone straight into the eyes when lifting or lowering a pallet. The last issue mentioned was the attitude questions. In the previous chapter it was mentioned that the attitude towards the goods, working safety and working equipment appeared to be quite poor, the same issue were mentioned here again.

6. VISIT RESULTS

As mentioned in Chapter 3, at least two different times and days were selected for the visits in order to obtain a sufficient overall picture of each warehouse. This chapter focuses on these results.

6.1 Terminal A

The first visit to terminal A was on Wednesday 7th July, 2010 at 11.00. At the moment there were very few people working and the terminal had a great deal of empty space. This time was really good to visit the premises as there was the possibility to focus more on other aspects than just on the forklift traffic. At that time there was no need to watch one's steps or observe the surrounding environment and it was easy to move around the warehouse.

Before entering the premises there was a small ramp. According to the Finnish working safety administration (2009, 7), every ramp having an angle in proportion of 1:8 is not considered good but these ramps should be at least equipped with a warning sign. Clearly

this ramp exceeded the minimum requirements but no warning signs could be seen. When entering the warehouse, the lighting was sufficient and it was quite easy to move from the bright outer spaces inside the warehouse. Due to bright summer days, there was no possibility to see how significant the difference would be during the winter time and moving from very dark into the warehouse. The light was quite pleasing to the eye as it was more of an orange shade and therefore there would not probably be any difficulties even in the winter time. Altogether there were five lights out but they were mostly at places where they would not make the working un-safer or slower. In overall the outlook of the warehouse was quite good. There were some pallets left lying around, small oil spills, some small particles and dirt on the floors, but nothing that could cause immediate danger for working. There was, however, several hand trucks left lying around where ever. This same issue concerned electric pallet trucks, which were left lying around in even more dangerous places. These dangerous places were in the middle of the aisles, behind corners and other places where it would be possible to hit the parked vehicles. In addition, it was strange how some single pallets with goods on them were left lying around basically everywhere, such as in the middle of the warehouse where there were no other pallets around. This was, however, most likely because there had been goods taken out of the rows of goods. Some of the pallets stored were very high with no additional securing such as plastic straps or binders. One possible hazardous situation could be caused by the loading docks of which some were not properly left after use. The normal position of the dock is for it to be at a 90 degree angle forming a small wall facing towards the inside of the warehouse. Without this wall there is a small possibility of driving accidentally out of the warehouse from the dock.

The driving speeds inside the warehouse appeared to be quite fast. Some forklifts were driven as fast as they could go. Driving was still mostly done correctly, for example when the pallet was too high, driving was done by reversing. No blinkers were used. However, compared to the quiet time and decreased amount of other traffic, the driving was done satisfactorily, at least from an outsider's point of view. As mentioned in the previous section, some single pallets with goods on them had been left lying around. This meant that there were basically no clear driving routes and the forklift drivers chose to drive

wherever they found it most convenient. Besides causing possible extra crossing traffic, this may damage the goods, when routes which are not normally used, are driven. Turning at unknown places may lead to goods being crushed by the rear of the forklift. All in all, the forklifts were in a good shape, they were quite clean and everything appeared to work as supposed. There was, however, no possibility to do any personal testing of the equipment. Related to behind the random locations of the pallets, was the inconsistent lining of the pallets. The pallets with goods are unloaded into the warehouse into rows. These rows were really uneven in terms of the spaces between the pallets and the straightness of the rows. This causes no straight harm for the working safety but material damages may increase as the pallets are stored crooked causing the whole rows to be crooked. This means that the pallets have to be taken out of and driven to the rows in a very special way. One has to take into account the pallet behind the pallet being lifted, drive between the pallet rows indirectly and especially when reversing one has to observe carefully that the pallet lifted does not hit the other pallets on other rows and, in addition, that the forklift does not hit other pallets. These crooked rows and pallets do not only cause possible material damages but they lead to time being used in an inefficient way. If the pallets had been properly unloaded into the rows, the loading and driving them out of the rows would be most probably faster and secure for the goods.

From an outsider's and pedestrian's point of view the moving inside the warehouse was quite dangerous. High pallets with no clear passages, sidewalks or bars dividing the areas between the forklift traffic and passenger traffic made the area quite unsecure for an outsider. In addition, there were no route marks. For a person who is not familiar with warehouses, it would have been impossible to know which passage was reserved for forklifts nor on which side were they to be driven. The doors on the other side of the building had been marked by small poles but they were sufficient in terms of height if compared to the relatively high pallets transported. This may cause hazardous situations if the doors cannot be clearly seen and perceived. The poles supporting the roof of the warehouse had no bumpers which may cause damages to the forks of the forklift and to the pole itself in the long run. As an additional remark of the current situation in the

warehouse, one part at the back of the warehouse was filled with goods that appeared to have been there for a very long time (see Figure 6).

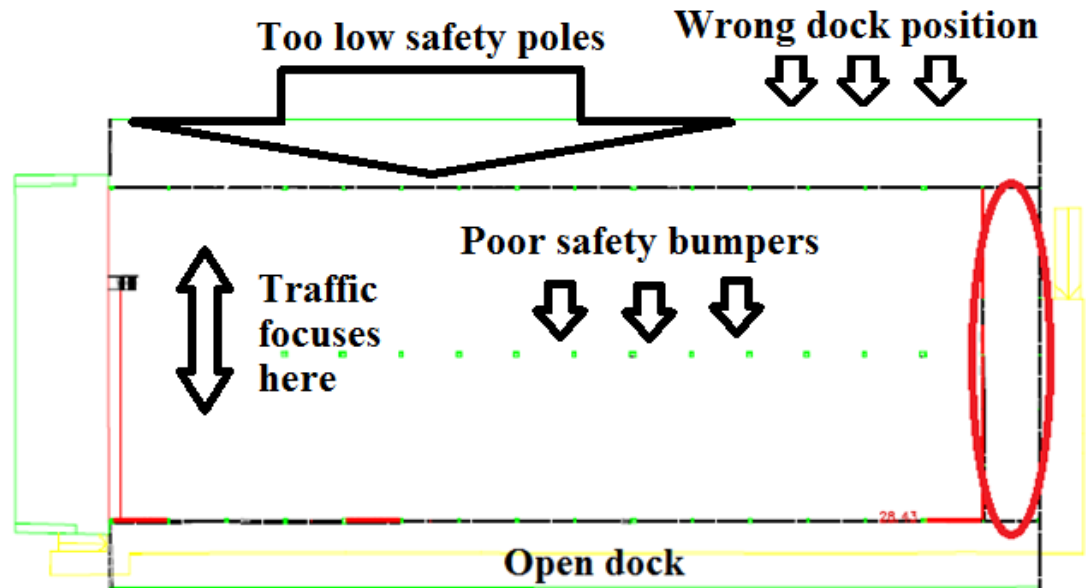


FIGURE 6. The layout of the warehouse A, probable unnecessary goods marked with red

The second visit was done at 4.30 in the ninth of July. This time was said to be one of the busiest times in this warehouse. This was true as there was a lot more traffic at this time than the previous time. This busy time means that more and more goods are moved around the warehouse, the traffic increases and the space is becoming more limited. This reflects mostly in case of the high goods such as fridges. The increase of these goods causes more limited view for everyone moving in the warehouse. Especially this is dangerous for pedestrians, such as truck drivers collecting their loads by hand, and electric pallet trucks. Furthermore, this may cause very surprising situations causing fast reactions possibly leading to pallets and goods to fall down on other people or goods. Most of the traffic focused on the office side of the warehouse where as the other end was quieter.

The driving had stayed in practice relatively the same compared to the more quiet time. Blinkers were not being used but, for example, reversing was done the right way. Empty pallets were still being left lying around causing diverse routes in the warehouse. A large

number of forklift drivers tend to use these new routes, which should not even exist, and this causes dangerous situations especially due to the need of quick reactions. Pallets that are left lying around, possibly without anyone noticing them, and people may drive into or over these pallets causing damage to the equipment or the goods. In overall, the widths in the warehouse stayed within the 4,2 meters agreed in the law if the pallets lying around were not calculated in. One issue that could be noticed during this second visit was that forklift drivers tend to cut corners frequently while driving in the warehouse. This may have been caused by the additional rush. When the drivers cut corners, especially in a warehouse with very high loads, they cause unnecessary danger both to the goods, due to the tighter turning angle and the danger of the load to tip over, but in addition to the forklift drivers or the people coming from the other direction. Cutting corners may save time, but the save is minimal compared to the risks associated with this kind of driving behavior. Unnecessary driving is something to be avoided and therefore driving to the breaks is somewhat of a concern, especially driving outside on the loading docks in order to have a cigarette break. One of the issues, which came into attention during this visit, was the volume of the radio with some drivers. The drivers drive mostly electric forklifts which move in the warehouse at a very low volume. The electric motors used in these forklifts are very quiet and if there is, as there usually is, a great deal of noise in the warehouse, it is hard to hear the forklifts move. Listening to music at a very high volume may cause distractions and communication mistakes while working.

6.2 Terminal C

The first visit to the C terminal took place at 12.15 in 7th July, 2010. The C terminal is busier than the A terminal in all aspects. Therefore even the first visit at this more quiet time offered a lot more to be noted. First issue to be noted when entering the terminal was how poor the lighting was. There were in total 42 lamps broken in the ceiling. This was not a significant problem during summer time, but unless the lights were not to be replaced before the winter, the lighting would probably be insufficient. Besides making the working more dangerous, the insufficient lighting is more time consuming as tags on the goods cannot be as easily read as in a proper lighting. At this time there were

numerous empty pallets, electric pallet trucks, forklifts lying around and some oil spills. Clearly there is no specific place where they should be left. The same issue concerned the pallets with goods loaded onto them. They were as well left lying around. However, the reason for this may be the same as with the A terminal that some goods had been picked up and others were not then moved back to the rows. Something to be noted in this warehouse was that on several occasions the pallets had been put in to the rows very quickly with large amounts of space between individual pallets, similar to the A terminal. The excessive speed while unloading could be noticed in the way the rows and pallets were crooked and put in from different directions in a way that space was wasted making the already limited space even smaller. The limited space could be expanded a little by using more of the now unused space, such as the loading dock at the back. The space limitations are extremely well visible at the office side of the warehouse where most of the traffic appears to be focusing (see Figure 7).

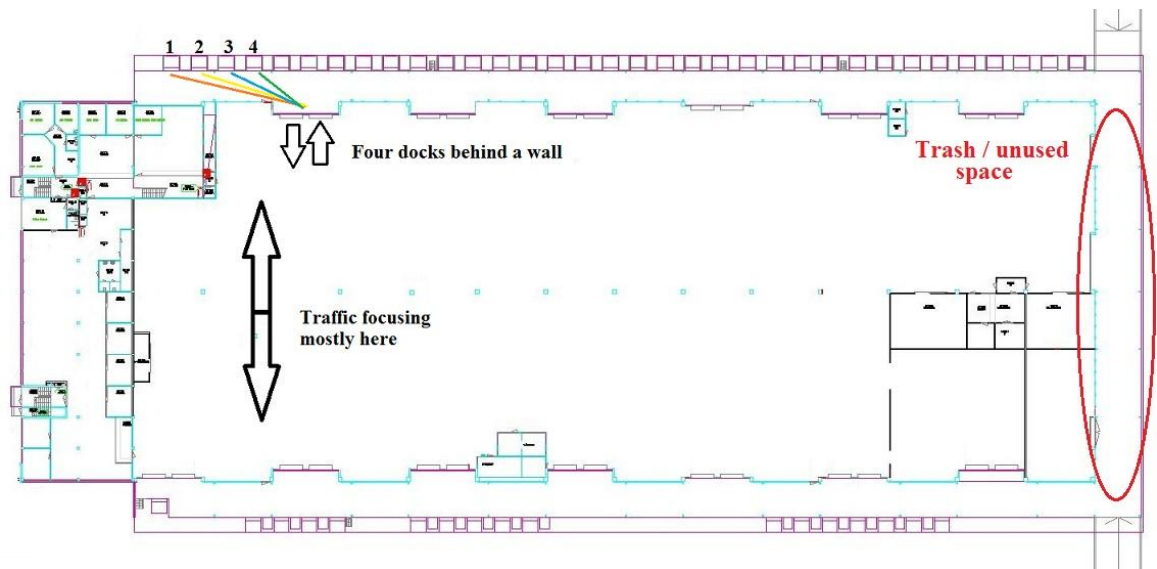


FIGURE 7. The layout and the problems at the terminal C

The driving itself was quite good, there was some blinkers used and forklifts were always driven at the right side of the road. There were a few signs indicating the driving routes but only a few. Clearly there were not sufficiently signs considering the size of the warehouse and the traffic in it. The driving speeds were quite high in this warehouse, similar to the A terminal. Due to more traffic, there were however more frequently

driving behind one another. The distances between two moving vehicles driving to the same directions were clearly insufficient. When two forklifts are driving very close to each other, and the vehicle driving in front of the other has to suddenly brake, the forklift behind it could be very likely to hit the vehicle in front of it. This occurred especially when there was an electric pallet truck in front and a normal forklift behind of it due to difference of the maximum speed between the two vehicles. This warehouse too contained numerous high pallets, which make the observing of the traffic quite hard. For the forklift drivers this means probable hard brakings, and possible dangerous situations occurring from it. Altogether, the driving in this warehouse was quite similar to the driving in A terminal. There were however some major threats in this warehouse. The first threat was the fact that forklifts were stopped in order to, for example, move cardboard boxes on or out of the pallet without using hand brake. This was quite dangerous as the forklift was still moving slightly when the driver jumped out of the vehicle. This could lead to serious injuries if the forklift starts to move by itself and hits someone or something while moving. This threatens the goods that are moved with the forklift, goods surrounding the equipment, the equipment itself and others, such as walls. Probably the drivers do know where they can do this, and where the ground is even, but this still appeared very dangerous, irresponsible, and should not be done. Second possible threat was that the lights in the forklifts were not used all the time. This is extremely dangerous as especially the other side of the terminal was very dark because the other side did not have an open dock structure but was filled with small loading platforms with walls separating the docks from each other. The darkness in this area meant that it was very hard to spot a forklift without the lights on coming behind a corner. The lack of mirrors did not help this. No mirrors and no lights meant that it was virtually impossible to detect a forklift coming behind a 90 degree corner from another forklift and, as seen in the previous picture, in the worst case there are altogether four forklifts driving around one corner. In addition, there were pallets moved in an irregular way in the C terminal. Two pallets were moved either by pushing them against the floor or both were lifted at the same time and then dragged against the floor. There were some quite high pallets, such as two pallets with large oil barrels on them, moved on top of each others. The pallets were not tied in any way and it could easily happen that the pallets would tip over.

If the oil barrels would fall down the consequences could be catastrophic. There would be material damages due to the leaked oil, the barrels could hit someone and the leaked oil would be most probably run over by other drivers and spread to the whole warehouse. Even though one might imagine that driving with two pallets on top of each other would speed things up, the very high load requires a great deal of concentration and the speed has to be slowed down severely. In addition, when others keep up their normal pace, which is usually fast, the driver may have to break suddenly and the risk of an accident increases. On the question of possible distractions, similar to the warehouse A, in this warehouse some drivers listened to music at a very high volume and most of the forklifts were electric forklifts.

On the question of pedestrian safety, the situation in this warehouse was quite similar to the situation at the A terminal. Even though there were two markings on the lanes where the forklifts would drive, no clear pedestrian routes were designed nor were there any bars separating the pedestrian traffic from the forklift traffic. The poles supporting the roof had safety bumpers in this warehouse but there were a few shelves which were not secured in any way. The shelves were not, however, actively used, but still they should have bumpers in case of a hit by a forklift. The doors had small vertical steel bars that acted as bumpers but they were quite low and of a wrong color. The bars were blue but another color with added height would work better as a safety bumper and the marker of the sides of the doors. Something to be noted at the doorways, were the plastic sheets that hang at the doors leading to the open dock area. They made the doorways quite low and some cardboard boxes and similar small items had to be moved out of the pallet because they would have hit the plastic sheets making the items to fall down. This is a working safety issue as forklifts have to be stopped in order to take the boxes down causing unnecessary moving of the goods, moving by foot in the warehouse and stopped forklifts blocking the routes where the other forklifts are driving.

The second visit to the C terminal was at 16.45 in 8th July, 2010. This was the other one of the two busy times. As the information gathered from the interviews and questionnaire forms revealed, the C terminal is extremely busy and full of goods around these times

every day, and this time appeared to be none different. There were a great deal of traffic and goods stored and moved around. The amount of goods was probably the most significant problem in the warehouse at this time and eventually leads to lack of space. However, even though this was a busy time, the forklift drivers drove quite adequately, probably due to the increased traffic. Probably the experiences they have gained through working in the warehouse have made them quite familiar with the different situations and they know what to look for and observe while working. With high loads the drivers drove by reversing. Blinkers were surprisingly quite well used and overall driving speeds were relatively low. However, the same problem that could be noticed during the first visit was present at this time; the distances when driving behind one another. Even though the drivers would be quite familiar with the increased amount of goods, limited space and increased traffic, they did not seem to be able to take into account that surprising situations are very likely to arise. Two pallets were moved at one time during this rush hour which causes similar issues as in the quiet time. The stability of the pallets appeared to be quite of a question, and actually one pallet full of cardboard boxes fell down while the visits were done. The goods fell down even if the pallet was moved at a really slow pace with an electronic pallet truck. Fortunately, the pallet was filled with quite light goods, and nothing was broken, but still this is something to take into account. The question of instable pallets had already come into attention in the interviews. In addition, there were several quite poorly packed pallets full of small cardboard boxes, and here is likely to occur material damages if the goods fall down from, occasionally very high, heights and hit the ground or other goods when landing. The issue of crooked rows and pallets was moreover present at this time. There was a great deal of waste space between the pallets, at times even distances of 10-20 cm. This causes a great deal of space to be used in an inefficient way. It is impossible to make every single pallet touch each other every single time, but this happened at times for ten different pallets in a row. If an average distance between the pallets was 10 cm this results as 80 cm of waste space. When thinking of the driving routes and the possible 80 cm increase in width, working safety and speed could be significantly improved. At the moment of this visit, it was raining heavily which revealed another small defect in this warehouse. The closed loading dock with several small loading platforms and rubber shields attached to the platforms,

appeared to steer all the water from outside in to the warehouse causing water to make the surface of the warehouse very slippery. Forklifts driving over the water enable the water to spread out everywhere in the warehouse. Water causes relatively similar effects as oil: the surface becomes slippery making controlling of the forklifts harder and increases the risk of an accident.

The third visit to the C-warehouse was at 5:30 in Friday 9th July, 2010. This is the time when the trucks are loaded up with small packages which are then delivered all over southern Finland. The third visit did not reveal new issues in the same scale as the two previous ones. Practically the same issues were there; two pallets were moved at the same time and the drivers were having their breaks and meetings at the doorways. Driving had stayed rather similar compared to the previously seen. At this time could be clearly noted that some drivers do not use lights when they are driving the forklifts. This is a hazard as some places are very dark, there are no mirrors and there are obstacles blocking the view and the electric forklifts are extremely quiet. As mentioned, the problems were similar to the problems noted earlier.

A few new issues still arise. This time, and especially the dawn, revealed a very dangerous issue. The side of the building with the sliding doors and closed dock had numerous windows. The windows were facing east. As the sun rises from the east, the whole warehouse faces a direct sunlight from outside. This is something to be noted when building the new warehouse at some point. The drivers' view was extremely limited by the sunlight, and some of them were forced to move their hand away from the control devices and keep in front of their eyes in order to see something. This is very dangerous in several ways and may lead to very severe material damages and human injuries. Besides this, in addition it causes unnecessary slowing down on the working pace. Second issue that could be noted, especially at this point when the drivers are collecting their loads according to their bill of lading, is the fact that there were numerous people walking around in the warehouse checking the packages and the labels on them. This means countless pedestrians among the forklifts, and some of the pedestrians did not have any safety clothing or attention colors on them. This was the first safety issue related to

the collecting of the loads, but the second one was the fact that several drivers were collecting their loads by checking the packages and labels from the forklift just by driving around the pallets and constantly checking the pallets whether the packages belong to them. This is unnecessary driving, and besides the forklifts becoming more used, in addition it is a hazard towards the goods lying on the floor and the other people and forklifts moving around the same packages and pallets. The focus is on the labels and not the surrounding environment causing unnecessary danger. One small accident actually happened as a truck driver was checking the packages by reversing and driving forward around the pallets and while reversing suddenly one package was hit. There were no clear damages that could be seen, at least to the outside of the box, but it is very likely that numerous material damages happen this way. Probably the question in this driving behavior is just laziness as probably parking the forklift and then trying to find the goods by foot would not take any more time. Most of the drivers handled their collecting by using their feet but a few did this by using the forklifts.

6.3 Terminal D

The first visit at the D terminal was at 13:00 on Wednesday 7th July, 2010. The D terminal is the terminal focusing on the foreign transportation operations at DB Schenker Cargo Oy. When entering the premises the overall picture was clearly the best of all the three terminals visited. The overall cleanliness of the premises was the first issue what caught attention. There was no excess dirt, oil or anything else on the floors. Only part where there was excess junk was the loading dock at the back of the warehouse which was filled with unnecessary items (see Figure 8). This is not necessarily straightly related to safety issues but more organized warehouse provides more space and more space means more tolerance in driving the forklifts in terms of space. Especially surprising in this warehouse was the fact that there were numerous signs indicating the routes where the forklifts are to be driven. This makes it very easy to approach the warehouse as a third person entering the premises. The overall lighting is very good, and in addition there were extra lights available at the loading docks if needed. Even though this thesis was done during the summer time, one could imagine that this improves the working safety and

visibility during the winter time when it is very dark outside. The visibility in overall was really good, most probably due to the vast amount of shelves. The D terminal is the only one with shelves that are actually actively used. The C terminal is equipped with a few shelves but supposedly they are not used to the extent as they could be. Even though the routes for the forklifts were clearly marked, there were no signs indicating where pedestrians should walk or any bars separating the traffics from one another. Other terminals could take note on how well the poles supporting the roof were protected; they were sufficient in terms of thickness, height and they were clearly marked with yellow attention color. The shelves were not too well protected but they were clearly protected in case of light hits, such as small reversing accidents. If something bad has to be named about the overall situation now it is the fact that there were some pallets lying on the aisles. The aisles were clearly sufficient in terms of width in order to them fulfill their function properly but the width was significantly deteriorated when there were pallets, empty or full, left in the middle or in the side of them. Extra points have to be handed out to the D terminal for being the only terminal of the three terminals using mirrors. There was only one mirror, thus there were not sufficiently mirrors but this was a step towards the right track.

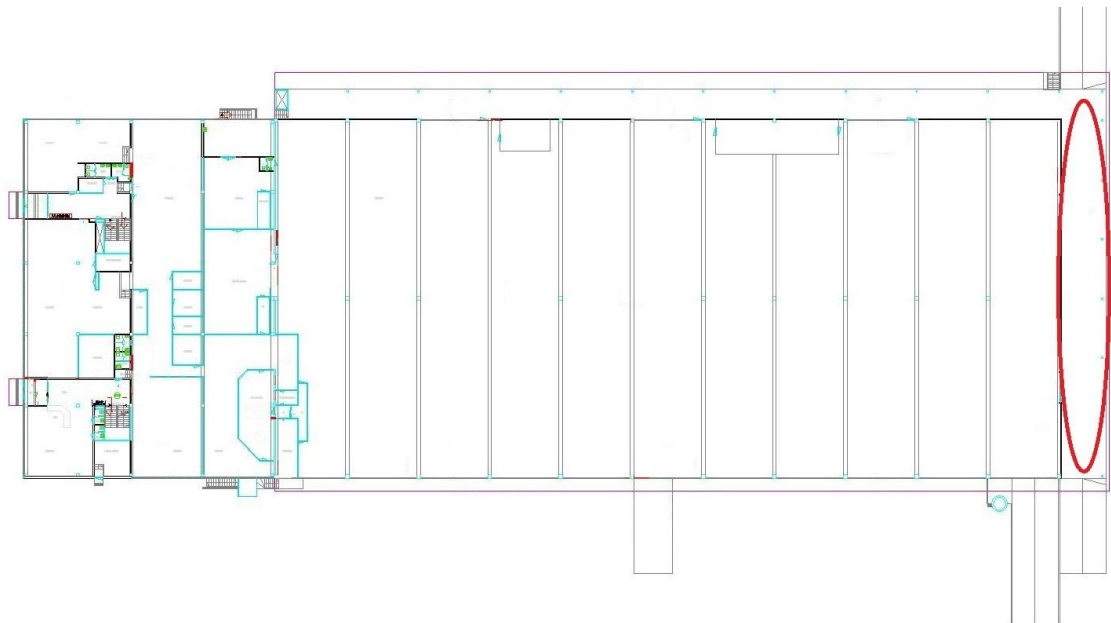


FIGURE 8. The layout of the D terminal, red indicating the dock with excess junk

The driving speeds inside the warehouse were quite high, practically at the same level with the other two terminals. Situations where another forklifts passes another one from behind, either when a forklift is reversing from a truck or when a forklift driving in front is turning, appeared quite dangerous but, as mentioned, the warehouse was quite quiet at this time and there was a great deal of space and visibility to do so. Blinkers were not used but this did not seem such a significant problem due to the overall cleanliness and openness of the space. Only issue differentiating from other warehouses was that it appeared that when the workers unloaded or loaded trucks, they gathered pallets in the sides of the loading docks where they were working. This blocks the sliding doors and the loading docks on the sides to be used and causes unnecessary obstacles for the view. However, the pallets were not there for a long time and at this quiet time this was possible, as there was no trucks coming to the other loading docks nor were there a great deal of forklift traffic inside the warehouse.

The second visit was on Friday 9th July, 2010 at 8:00. This day was selected on the basis of the interviews as it was mentioned frequently by several persons that Friday was extremely busy day for foreign transports as goods had to be moved before the weekend. Even though this day was said to be the busiest one of the week, there was still no chaos or rush to be noticed. In overall, the situation was greatly calmer compared to the other two warehouses and their rush hours. The D terminal was so quiet that it was hard to make any new notes or comparison to the more quiet time. The same issues were present at this time, such as leaving the pallets in front of the sliding doors which are on the side of the loading dock that is being used. The increase in the amount of goods meant that there were many new goods of different shape and size being stored into the warehouse. Some of these pallets were very high and this lead to the same conclusion as with other two terminals; lack of safety clothing and attention colors in the clothing and lack of proper view, due to wide and high pallets, may mean immediate danger to the electric pallet truck drivers and pedestrians walking among the stored pallets. In addition, some of the forklifts were not driven with the lights on. Lack of safety clothing and forklifts without lights may cause dangerous situation, especially when driving at a darker place in

the warehouse or when driving through corners. As mentioned, the same issues were present as with the more quiet time, but there were a few exceptions. One was that the forklift drivers were making extremely tight turns when changing the side where they wanted to lift a pallet. High speed and tight cornering causes unnecessary danger to the machinery, personnel and goods. The saving in time is extremely minimal but the danger of tipping over increases. This is probably due to unawareness, lack of interest towards the equipment and goods or just because of the fun of it. Related to the lack of respect towards the goods, was moving of some of the cardboard boxes by crushing the box between the forks. This is extremely disrespecting towards the goods, and even though no visible damages can be detected, this is very likely to cause damages to the goods. This kind of disrespect towards the goods moved and stored should not be tolerated and should be removed completely.

7 IMPROVEMENTS TO THE CURRENT SITUATION

As the visits and the interviews revealed, there are countless issues that need to be improved. The most important issue is probably the attitude question of the workers, which concerned every single warehouse. Like many other issues, attitudes are very hard to correct. It has to be clarified to the warehouse workers why changes are made and why their operations are being influenced. The first step for improving their attitude is to convince them that changes are good and it is everyone's benefit to make the required changes in order to improve the working safety. If changes are just announced, they find it very intrusive and they probably think that their work is made harder and time will be lost due to nothing important. Changes, and the reasons behind the changes, have to be thoroughly explained. Explaining these reasons could be done in small groups by having a meeting in order to make sure that everyone is reached, everyone then knows about the changes and there will be no any open questions or confusion left. Reasons have to be explained from their point of view. For example, safety vests and attention colors make their job easier and faster as they can focus on the pallet moved and the route; unnecessary constant observation of the environment can be decreased and eventually

speed increases. The same concerns the mirrors; mirrors make their observation easier, they are able to know whether someone comes from behind the corner and, again, less observation leads to a faster work pace. The compulsory use of the driving lights on the forklifts can be explained with the same explanation of improved work pace. The topics that came up during the visits to the warehouses have to be discussed thoroughly and common principles have to be agreed on. These principles have to take into account the common guidelines in the warehouse, such as where the places are to have their breaks, where the forklifts are being parked, where the empty pallets are being laid, and that all the mess caused while working has to be cleaned up. The importance of working safety has to be clarified, and the fact that it is not just about their working performance or that they might have to have some days off from work because of an injury. The worst case scenario has to be thought of and in the worst possible situation they might be crushed really badly, hit with the forks of the forklift or get run over. In these cases it is not about a few sick leaves, it is about a possible permanent injury, paralysis or even death. The changes are made in order for these situations not to occur. In addition, it could be mentioned during the meetings, that this is the reason behind the “accidents that nearly happened”-form. The purpose of the form is not to point out the people responsible for the almost happened accidents, but to think of the reasons behind them and improve the situation. In order for these forms to be filled out, stricter control has to be carried out by the foremen and they must insist on the forms being filled out. One option could be that there is the possibility for the workers to fill out the form at the end of the day and every single month the foreman will take his team into a short discussion where the problems are talked through and the reasons behind them carefully considered. Discussions, observing and meetings are time consuming and require a lot of effort from the foremen, but this way it is quite an easy way to make it clear that this is important for the company and a concern for everyone in the company.

In order for the workers to make improvements themselves and think of the working safety, they have to be motivated somehow. The motivation can be created by previously mentioned discussions, but it can be created via other routes. One possibility is to give out

bonuses when the workers are able to keep working accidents below a certain level or when the material damages are decreased by a certain percentage compared to some other time. The bonuses could be cash but other options could be days off with paid, free lunches or anything that can be imagined. However, as the questionnaire forms given out at terminal C revealed, motivating, even with bonuses, can be difficult. In addition, the bonuses could be handed out if the warehouse workers or managers could give some feasible further improvement suggestions. This could be carried, for example, by having a small box at the cafeteria where feedback and improvements could be given. At the moment there is a box for nearly happened accidents, and this box could act as the box for improvement suggestions. In addition there should be the option to give feedback anonymously. The behavior in terminal C revealed that the foremen have to be severely taken into account when emphasizing the importance of the project of improving the forklift traffic safety. It was frequently mentioned to them that these forms are important for this research, and they were unable to motivate the warehouse workers to fill them out. This could be interpreted in a way that even the foremen were not interested of this topic. It is clear that the warehouse workers will not care of the changes, improving the forklift traffic and working safety in general if the foremen have a poor attitude towards it. The foremen have to act as role models for the warehouse workers and once the foremen are doing their work as safely and exemplary as possible they are in the position where they can actually be able to tell the workers how to operate their vehicles and eventually improve the current situation.

Other important improvement suggestion concerning every single warehouse is to have a rack for hanging safety vests. Safety vests should be provided by Schenker and they must be worn when entering the warehouse. Every single person, whether they are truck drivers, warehouse workers or just occasional visitors, must wear these vests. Wearing the safety vests appeared to be among the workers an attitude question, and some people might find the vests to be extremely uncomfortable and they might find that the vests make working harder. It cannot be sufficiently emphasized that this is not a recommendation but a must. How to change the warehouse workers' attitude is very hard but this a question of strict regulations and the foremen have to remark when the vests are

not worn. This issue could be explained in the meetings in a way that the working eventually becomes faster as workers are clearly visible and can be seen when they are walking in the warehouse. Less to be observed means that the focus can be pointed out to working and driving.

7.1 Improvements to Terminal A

The main problems with the warehouse A was its poor condition, vast amount of high pallets and occasional lack of space. The goods moving in the warehouse cannot be limited in terms of maximum height or width. Therefore probably more attention should be pointed towards to the storing locations of the goods. At the moment they were frequently stored at the middle and when there were people walking in the warehouse, it was very hard to notice these people. When these goods were stored closer to the walls, and not in the middle, pedestrian safety would increase. Whether the pallets cannot be stored near the walls, mirrors should be installed to the supporting poles of the roof. Mirrors have to be added at least to the doors leading to the loading docks outside in order to increase visibility while cornering. Other obligatory add-ons are the signs indicating the driving routes for the forklifts. There were no markings indicating the routes, or they had worn off, and this could be corrected by painting new ones. However, as it is not clear when the new warehouses will be built, economically wiser would probably be to use normal paint instead of durable coating. Marking the routes and rows for the goods would increase the accuracy in laying down the pallets and increase the efficient usage of the space. Markings on the sides of the rows would help laying down the pallets in a non-crooked way. The poles supporting the roof could be equipped with thicker and higher safety bumpers. In addition, the safety would be increased by installing higher bars indicating the sides of the doors to the main doors leading to the loading docks on each side. One issue to consider is the problem of the forklift traffic focusing mainly on one side of the warehouse. Forklift traffic focused greatly to the side near the offices as on the other side, and probably by changing some of the destinations in the warehouse this could be affected and the traffic spread more evenly.

The lack of space is very hard to solve without making any structural changes in to the warehouse. The space could be still increased simply by cleaning the warehouse thoroughly and making an inventory. As mentioned in the problems that were spotted during the visits, one part of the warehouse was filled with, what appeared to be, very old goods. This fact became mentioned in one of the interviews. Countless square meters could be freed this way. This saved space could be then used for storing other goods or by building a parking and a charging place for forklifts. At the moment there were several charging points at random locations situated throughout the warehouse when probably one single charging place could make the warehouse clearer and cleaner. The same could happen with empty pallets and they could be stored only into one place instead of several, as at this point (see Figure 9).

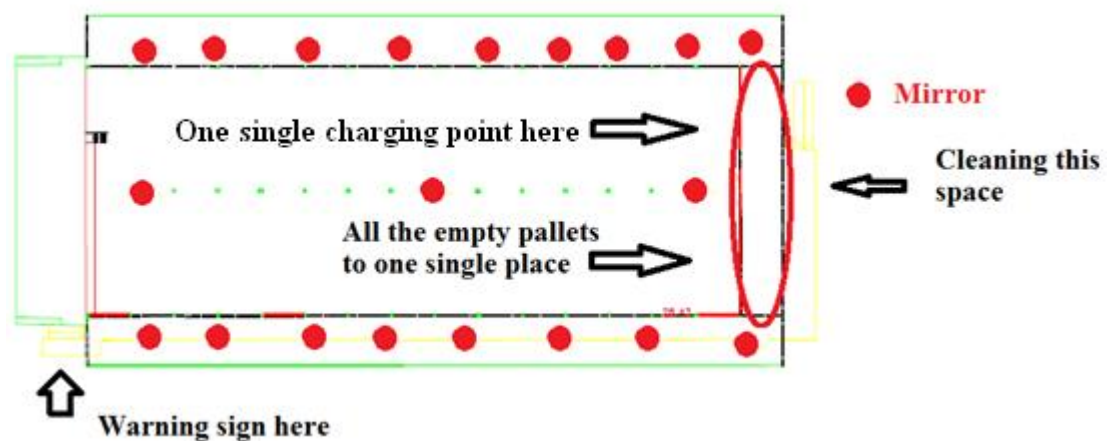


FIGURE 9. Improvements to the warehouse A

7.2 Improvements to Terminal C

The improvements to the warehouse C are rather similar to the improvement in the warehouse A as similar problems were present in this warehouse. The main problem, even worse here, was the lack of space. The C terminal clearly has the most goods moving in it and this reflects instantly to the use of space. Even though the space is limited, and structural changes are difficult to make happen, something can still be done.

Mostly these issues are related to the overall cleanliness. The empty pallets should be stored in this warehouse only in one place and not just leave lying around for further use. The space for these pallets can be created by removing the shelves that are located in the warehouse currently (see Figure 10). They are not clearly in active use and cause mainly only waste of space. Basically they could be used more actively, but as most of the goods move quickly in and out of the warehouse, there is no need for this amount of long term storage space. This procedure would release carefully estimated at least a space of 100 square meters. This space could be used for storing both empty pallets and goods on pallets. One possible usage for this space could be building a parking place for the forklifts as it already had charging points. Removing the shelves would release a great deal of space for the warehouse to be used for different purpose and make its life time longer. Similar to the warehouse A, mirrors need to be installed to every single corner with poor visibility. These corners are at every single doorway leading to the docks and to the loading dock at the back part of the warehouse. The C terminal had a few signs indicating the routes where the forklifts are driving but they could be increased. The C terminal had countless lights that were not functional and these lights should be fixed as soon as possible. As mentioned, the A- and C terminal were rather similar regarding several aspects, and similar was the forklift traffic as it mainly focused mainly on one side. Near the offices the forklift traffic appeared to be way busier and probably by changing some of the destinations the forklift traffic could be evened in the warehouse.

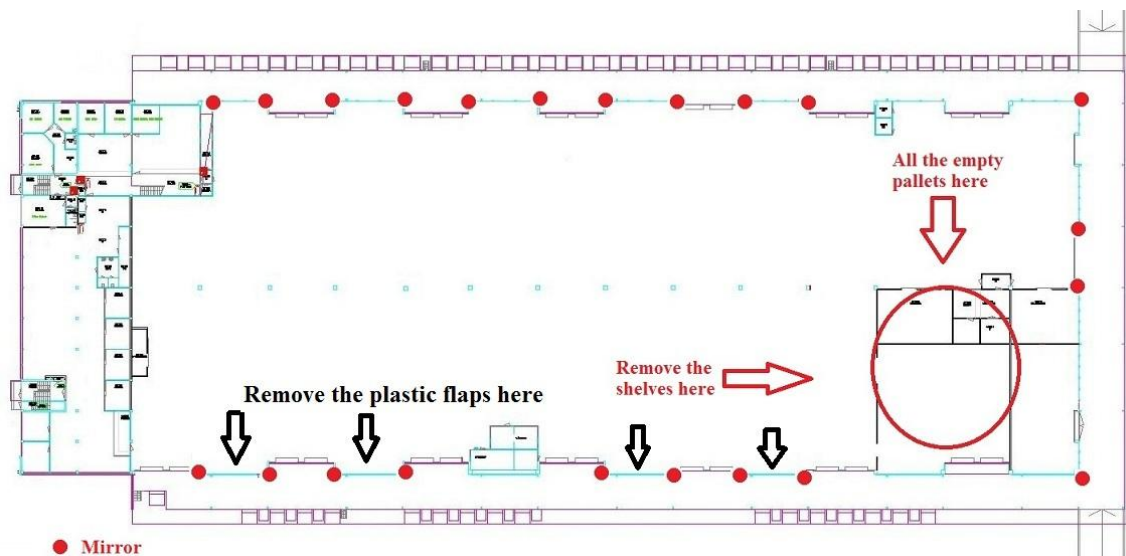


FIGURE 10. Layout and the improvements to the warehouse C

7.3 Improvements to Terminal D

The D terminal was the only one using mirrors but even at this warehouse there were not sufficiently of them. Mirrors would make the warehouse safer especially in terms of cornering. Every single doorway should have two mirrors for added visibility to both directions. The terminal D was in the best condition and operated quite safely. However, route markings could be increased. There were already a few markings but additional ones would make sure that everyone moving in the warehouse understands how the forklifts move there. The question of separating the pedestrian traffic from the forklift traffic is virtually impossible to solve. The reason for this is the physical premises and the fact that they are not designed in a way that they would take it into account. In addition, designing and building new passages for pedestrians would be very expensive. The D terminal was very well lit up, and very clear to move already as it is that there is no immediate need for separating the traffics from each other. The only immediate improvements to the current situation are quite small and are meant to improve the cleanliness, create more space and improve visibility in the warehouse (see Figure 11).

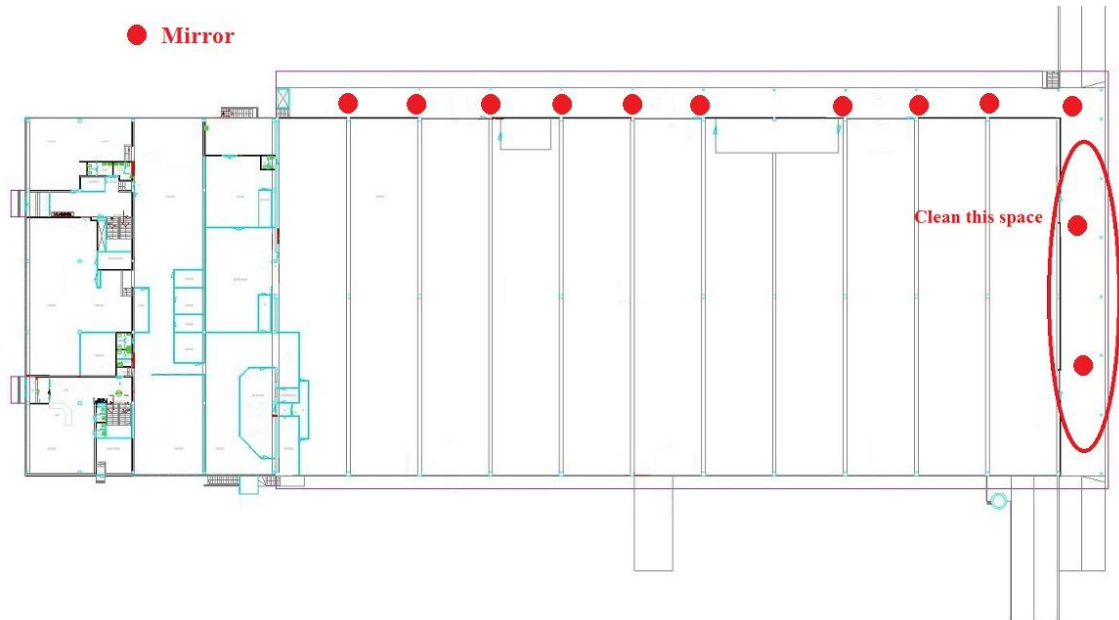


FIGURE 11. The layout and the improvements to the terminal D

8 HAZSCAN ANALYSIS

Due to the vast number of issues to be developed and improved, the current situation can be analyzed in a clear way by a HAZSCAN analysis. In this analysis all of the problem areas are identified and their probable consequences are listed in a table (see Table 2). In the table can be also seen how the situation is prevented from happening at this point and how it could be prevented in the future by making some improvements. This analysis reveals and lists all of the aspects that were noted during the visits, interviews and questionnaires.

TABLE 2. The HAZSCAN Analysis of the current situation

Dangerous situation	Possible consequences	Classification	Situation Now	Improvement suggestions
Blinkers not being used	Communication errors, collisions,	AMo	Tries to be controlled	Meetings, discussions,

	material damages, injuries			foreman control
Breaks at wrong places	Collisions, evasive turns, hard brakings, decrease in working speed	AMi	Indication of the right places for breaks	Emphasizing the importance of having breaks in right places by signs and meetings
Crooked/loose unloading	Poor use of space, material damages, decrease in work speed	AMi	Not controlled	Meetings, discussions, foreman control
Cutting corners	Collisions, material damages, hard brakings, evasive turns, collisions, injuries	UMo	Not controlled	Meetings, discussions, foreman control
Direct sunlight to the eye	Decrease in working speed, mistakes in handling the vehicles, injuries	PMo	Cannot be controlled	Blocking the windows at the ceilings and walls
Dirt on the surfaces	Increase in brakings, material damages	UMi	Tries to be controlled	Extra cleaning, cleaning after working
Driving by forklifts for a break	Unnecessary driving, decrease in work speed, collisions	UMi	Tries to be controlled	Meetings, discussions, foreman control
Driving distances from	Collisions, hard brakings, evasive	AMa	Not controlled	Meetings, discussions,

one another	turns, material damages, injuries			foreman control
Driving from behind a corner	Collisions, severe injuries, hard brakings, material damages, evasive turns	AMa	A few mirrors	Increase mirrors, wear safety clothing, use lights on the forklifts
Fluctuation in the amount of goods	Decrease in space and working speed	AMi	Cannot be controlled	Proper use of all of the warehouse space
Forklifts falsely parked	Collisions, evasive turns, hard brakings	PMo	Not controlled	One single parking place, re-organizing the premise
Forklifts passing each others	Evasive turns, hard brakings, material damages, collisions	PMo	Not controlled	Meetings, discussions, foreman control
Gathering loads by forklifts	Material damages, mild injuries	AMi	Not controlled	Prohibiting this behavior
Goods lying around	Material damages, evasive turns, hard brakings, collisions	LMi	Tried to warehoused in a certain way	Emphasize the importance of goods being in right places, re-organizing pallet rows after goods have been taken out
High goods	Poor view for the	AMo	Cannot be	Storing these

stored in the warehouse	drivers, collisions, evasive turns, material damages, severe injuries		controlled	kind of goods near the walls or other less traffic-oriented place
High number of beginners	Material damages, injuries	PMi	Tries to be controlled	Dividing beginners in to smaller groups with different instructors
Insufficient aisle widths	Poor use of space, material damages, collisions	AMo	Tries to be controlled	Re-organize the destinations, unload the pallets tightly
Insufficient doors' side indicators	Material damages, collisions, damage to the premises	UMi	Not controlled	Increase the height and colors on the indicators
Insufficient space	Material damages, injuries, decrease in working speed	AMo	Cannot be controlled	Proper use of all of the warehouse space, re-organizing
Lack of safety clothing	Evasive turns, hard brakings, severe injuries, death	AS	Not controlled	Force everyone moving in the warehouse to wear safety clothing
Lights on the forklifts not being used	Communication errors, decrease in working speed,	AMo	Not controlled	Meetings, discussions, foreman control

	collisions, injuries			
Loading docks left the wrong way after use	Driving out of the warehouse in to the ground, vehicle damages	RS	Not controlled	Meetings, discussions, foreman control , prohibit this action
No mirrors	Insufficient view to the drivers, collisions, severe injuries, decrease in working speed	LMa	Not controlled	Increase the number of mirrors
No separation of pedestrian traffic	Injuries, hard brakings, evasive turns	PS	Not controlled	Instruct pedestrians, wearing of safety clothing
No warning signs	Severe injuries, pedestrians in wrong places, driving in wrong places	PS	Not controlled	Increase the number of warning signs
Pallets lying around	Material damages, evasive turns, hard brakings, collisions	AMi	Tried to be put in certain places	Emphasize the importance of pallets being in right places, gathering pallets in certain places
Plastic sheets at the doorways	Unnecessary temporary parking, collisions,	PI	Not controlled	Remove the plastic sheets

	material damages, injuries			
Poor attitude towards the goods	Material damages	AMa	Tries to be controlled	Meetings, discussions
Poor bumpers on the shelves	Total collapse of the shelves in case of a hit, injuries, material damages	UI	Not controlled	Reinforce the bumpers
Poor condition of the premises	Material damages, decrease in working speeds	AMi	Tries to be controlled	Risks can be decreased by keeping the warehouse clean
Poor condition of the vehicles	Injuries, mistakes	PMi	Tries to be controlled	Reporting when something is broken
Poor lighting	Dark places, material damages	PMi	Tries to be controlled	Fix broken lights, increase lights
Poor safety bumpers	Vehicle damages, material damages	UI	Not controlled	Increase the wall thickness, re-paint
Radio being too loud	Communication errors, distractions, injuries	AMi	Not controlled	Prohibiting this behavior
Rain pouring into the premises	Increase in braking distances, mistakes in equipment	PI	Not controlled	Re-build, replace broken plastic sheets with new ones

	handling, collisions			
Stopping without using handbrake	Material damages, collisions	AMi	Not controlled	Prohibiting this action
Too high driving speeds	Severe injuries, collisions, material damages	AMa	Not controlled	Prohibiting this action, possible limiters
Traffic focusing unevenly	Poor use of space, collisions, evasive turns, hard brakings	AMo	Not controlled	Re-organize the destinations
Two pallets being moved at one time	Material damages, injuries	AMi	Not controlled	Meetings, discussions, foreman control, prohibit this action
Unstable/broken pallets	Injuries, material damages	Ami	Tries to be controlled	Securing that the pallet is stable, possible fixing
Unused space	Poor use of space, evasive turns, hard brakings, collisions, injuries, material damages	AI	Not controlled	Re-organize the premises and destinations
Wrong goods inside the warehouse	Decrease in space, material damages, equipment damages, decrease	AMo	Not controlled, especially at D terminal as	Increase the amount and use of outdoor warehouses

	in work speed		it lacks an outdoor warehouse	
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Every single dangerous situation is also categorized according to the likeness of them actually happening (see Table 3). On the left hand side is listed the likeliness of the event to happen, which varies between rare, which are situations which almost never happen, and almost certain, which are everyday situations. The consequences on the upper part of the table vary between insignificant, which do not cause any kind of damages to the personnel, equipment or goods, and severe, which are severe injuries, death and irreversible damage to the goods. The likelihood is determined mostly by the visits and the author's own perspective and for the consequences are considered to be the worst case scenario. In practice, the color of the category, where the situations are located in, indicates their importance, and the categories marked with red are the most urgent ones and have to be dealt with the first.

TABLE 3. The categories used in the HAZSCAN Analysis

	Consequences				
Likelihood	Insignificant	Minor	Moderate	Major	Severe
Almost certain	AI	AMi	AMo	AMa	As
Likely	LI	LMi	LMo	LMa	LS
Possible	PI	PMi	PMo	PMa	PS
Unlikely	UI	UMi	UMo	UMa	US
Rare	RI	RMi	RMo	RMa	RS

9 FUTURE WAREHOUSES

As frequently mentioned above, the current warehouses were built a long time ago and they are starting to be old-fashioned. Therefore DB Schenker will move into new premises at some point. The old premises clearly are not designed for this amount of cargo to be handled. The first issue to be noted is that there must be sufficiently space in the new premises. The next premises once built are probably meant to last for at least 20-30 years, and therefore it is important to focus on the premises having sufficient space up until the year 2040. The premises should be adequate in size and shape from the very beginning because expanding the warehouse later on would be very expensive. If one needs to expand a warehouse, at least one wall has to be demolished and a new wall and the surface structure have to be built. There are, however, significant expenses connected to the running costs if the warehouse is too large at the first time. Money has to be spent probably on unnecessary heating, lighting and other variable costs, but in terms of working safety, the safety of forklift traffic and material damages, it is recommended to build a warehouse sized sufficiently at the very first time. The reason behind this is that more space results as more spaciousness in the premises, which eventually leads to a better view for the forklift drivers, more space for the forklifts to operate in, fewer dangerous situations as there is more space where to make quick evasive turns in case of imminent collision. More space reflects on fewer goods damaged as they can probably be unloaded into the warehouse less tightly. Wider aisles, and more space to operate on probably mean less possible reversing-related damages or damages done to the goods while turning. The importance of the premises being built in the right way in at the start becomes very obvious when looking at the current warehouses. The C terminal has been extended at some point and, as a result, the surfaces and floors inside the warehouse are quite uneven. When driven at a fast speed, the goods are quite likely to fall down or fly from the pallet on to the ground causing material damages. If concentrating on speed, this small seam slows things down unnecessarily. Probably making a completely even floor in a new extension would be way too expensive and very hard to even accomplish. Making the premises in the right way and the right size at the first time is the key to a functional, long lasting warehouse. The shape of the premises should be symmetrical in order to

avoid unnecessary crossing forklift traffic as could be seen in the current terminals. As the visits to the warehouses revealed, there are numerous loading docks that have only one doorway leading to them. For the new warehouses, every single loading dock and sliding door should have only one passage. The decrease in the amount of crossing traffic decreases possible collision threats, makes the warehouse clearer and eventually increases working pace as the forklift drivers do not have to constantly observe the surrounding environment.

The fact that none of the warehouses observed in this thesis had proper route marking, especially terminal A and C, has to be corrected in the future warehouses. Every single aisle should have several signs indicating the route and whether it is a one way or a two way road. In addition, the sign should indicate the side of the road where the forklifts are driven, similar to the markings in the D terminal. The separation of the pedestrian traffic and forklift traffic is quite hard to establish. One possibility is to have sidewalks on the sides of the warehouse near the walls. These sidewalks should be clearly marked with the yellow attention color and separated by steel bars. The proper width could be 50 cm. By separating the sidewalks by steel bars it would be possible to utilize the rest of the space properly. Pallets could be pushed very near the steel bars, even lightly hitting them, without making the sidewalks unusable. By having the sidewalks at the side, it would be ensured that in the middle, where the forklifts are moving, there would be no people moving who do not know how to behave there. Basically all the people moving in the middle know the dangers related to forklift traffic and they know what to look out for. Of course, similar to the improvement list, every single person moving, by foot or with a forklift, has to wear safety clothing. If the security for the pedestrians were wanted to be maximized, the warehouses should have pedestrian crossings clearly marked with the white color or similar obtrusive color. However, the volume of the goods being moved in these warehouses and the forklift traffic resulting from it is so vast that this is not possible. Using pedestrian crossings would most probably slow things down at first, but as the pedestrian traffic is quite modest, the forklift drivers would not eventually respect the crossings at all, making them completely useless.

As the visits revealed, the rows where the pallets are driven were very crooked. The fact that the floors have no markings indicating whether the rows were straight is clearly a problem. This causes the drivers to be unconcerned about whether they put their pallets straight according to the rows. In addition, this made the warehouses very unclear in terms of where the goods were to be unloaded. The floor had had markings previously, but the constant driving on the floor throughout the years had worn off all the markings. In order for the marking to stay on the floor, one possibility is to use markings that are widely used in road marking on Finnish roads. These markings are called durable markings, which are more wear resistant. They can be made by heating up a certain type of pulp which is then poured on to the surface of the floor or they can be made by making little insets on the surface. Even though the paint would wear off, the insets would most probably still have the paint indicating where the pallets should be driven and how much space is reserved for them. The only question with durable markings is the durability. The markings will last for a long time and the purpose of the warehouse might change during this time. There might appear more destinations, the amount of goods on different destinations might change, some destinations might be dropped off, or the whole purpose of the warehouse might change and a terminal designated for foreign traffic might become the terminal for transportations inside Finland. In this case the markings would still be there, but they would be useless. The durable markings should probably be used to a certain extent, for example for marking the main routes. This would mean that even though the warehouse would change its purpose or functions, the main routes would still be there allowing more flexibility.

Other things to be noted are to have certain areas reserved just for some purpose. The first matter is to have areas for different functions. One certain place should be reserved for loading the electric forklifts, one place for empty pallets and one for all the office functions. At the moment, the pallets are mostly in piles but scattered all around the warehouses and these make the current warehouses seem smaller than they actually are. In addition, charging points are located in various different places even in one warehouse. One issue to be removed was the fact that at the moment there were numerous small buildings and offices reserved for the personnel inside the warehouse. In order to promote

the symmetrical shape in the warehouse, these offices should be located in with the other office premises with only a passage to the warehouse (see Figure 12).

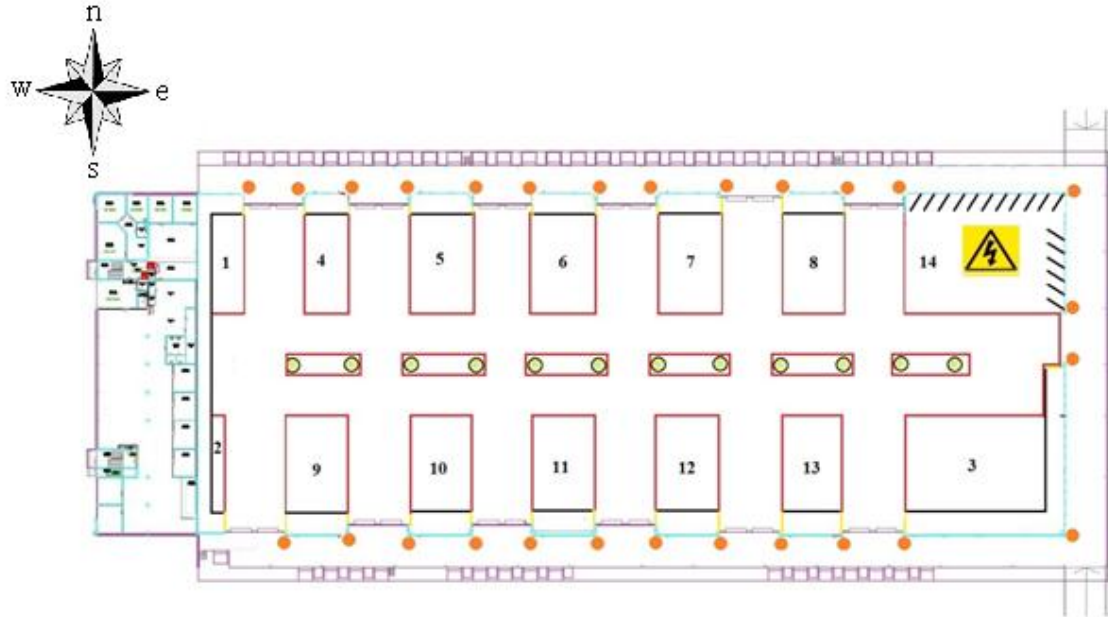


FIGURE 12. Possible layout of the future warehouses

The figure above shows what a future warehouse could look like. In this warehouse the layout has been made quite simple and different parts of the warehouse have a different purpose. The layout in the picture is made very symmetrical in order to avoid unnecessary driving and to make the warehouse very clear and easy to operate in. In addition, the symmetrical shape decreases the amount of corners with a poor visibility and decreases the amount of crossing traffic. In the current warehouse even up to four different forklifts may drive through the same corner around the doorways while loading or unloading but in this warehouse the number decreases to two. In order to create this symmetrical shape, all the office buildings have been moved to the same part of the building, in this case to the left hand side. Numbers from one to three are designed to be places where the empty pallets would be driven to, one and two being the temporary slots and three being the primary slot for the empty pallets. This way there would be places for empty pallets in each side of the warehouse and there is no need to drive the empty pallets constantly to slot three. The pallets would be stored into piles at first and then driven to slot three when

the situation calms down and there is less traffic. By having several slots reserved only for empty pallets, it would be possible to store the pallets in an organized way, not having them lying around in the warehouse. To the top right hand corner opposite to slot three, in the slot 14, there is a place reserved for charging the electric forklifts. In addition, this place could be used as a common parking place for all of the forklifts. By having a clear parking places for the forklifts, perhaps with every single forklift having a number and a place reserved just for the specific vehicle, the vehicles could be parked and kept in only one place making it sure that they are left where they are supposed to. By having the forklifts in only one place it would be extremely easy to keep track of the equipment and their condition. This place should be equipped with rags, sponges and other cleaning materials in order that, for example, the windows of the forklifts could be washed. The parking places are shown as the oblique black lines. Oblique lines save space and more forklifts can be stored in a smaller space. The slots from four to thirteen are reserved for the goods that are being loaded and unloaded. The red that separates the slots from each other demonstrates how the durable markings should be made. This is a very common layout used in warehouses, which makes it possible that even if the warehouse changes some of its functions or destinations, the markings will not be completely wrong. In order to avoid reworking it would probably be best to have the markings around the roof supporting poles by having insets and the rest by painting. The poles have been properly secured in the layout plan and have a thick wall around them in order to make them more wear- and hit resistant. The color of the safety bumper is designed to be yellow and black. As an additional safety measure in the warehouse is the vast number of mirrors, marked with an orange color in the picture. The symmetrical design and increased amount of doorways already decreases the amount of crossing traffic and with the vast number of mirrors, in total 27 pieces, the minimized traffic in the loading docks should be easy for everyone to monitor. The vast number of mirrors makes every corner visible and working around them safe.

As for the pedestrian safety, this warehouse has been designed to have walking aisles in the inside of the warehouse next to the wall. The pedestrian sidewalk has been separated from the middle of the warehouse with steel bars, shown as black in the picture. The

sidewalk could be perhaps raised slightly from the common floor level in the warehouse and painted with an attention color, such as black with yellow stripes. This is to illustrate to the forklift drivers where any pallets should not be stored. As mentioned previously, it is not possible to make the pedestrian privileged. It is possible, however, to create clear boundaries between the forklifts and pedestrians. Even though the pedestrian is not privileged in relation to the forklifts, the warehouse workers now know where the pedestrians are likely to walk from and they know which places they have to look out for. Having the pedestrian routes at the side is the simplest way to create a safe environment for the pedestrians, keep the possibility of fast moving and working in the warehouse with the forklifts, and not to use vast amounts of space from the warehouse.

As for the physical location of the warehouse, on to the left hand upper corner all the main points are shown. The main points indicate that the walls and the windows of the warehouse section of the building should not face east or west. These directions are the directions of sunset and dawn. By locating the building this way it is possible to avoid direct sunlight coming into the warehouse and causing similar problems as in warehouse C in the morning time. The building should not have any windows on the roof, either, for the same reason, the sunshine coming in throughout the day.

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Appendices

Appendix 1. Questionnaire Form

Name: _____ (Only for the lottery)

Sex: Male
 Female

Age: <25
 25–35
 35–50
 50+

Education: Basic education in logistics
 University of Applied sciences education in logistics, or similar
 Student, field of studies? _____
 Something else, what? _____

Working history in the field of logistics (position, duration, company):

Working history at DB Schenker Ltd (position & duration):

Possible working accident history (if several, choose the latest one(s)):

When (year, season, clock)?

What happened?

Why?

Problems in the working safety:

How do you experience the current working safety situation?

What is problematic in the current working safety situation?

Improvements:

How would YOU improve the working safety at DB Schenker Cargo Ltd?

Thank you for your answers, your opinions are important and will be taken into account!

Appendix 2. Additional Page

Which of the workers do you think cause most of the unsafe situations?

Appendix 3. Check list for the visits

Driving in and out?

Visibility at corners?

The number of route markings on the ground?

The number of route signs?

The number and markings of intersections?

Wearing of safety clothing?

Driving speeds?

Lighting, number of dark places?

Condition of the forklifts (lights, brakes, blinkers)?

Safety bars?

Number of mirrors?

Ramps, condition of the surfaces?

Aisle widths?

Bumpers on shelves?

Heights at doorways, warning signs?

General cleanliness?
